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JC675 U.S. PTO

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Docket No. 004947

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

Re: Inventor(s): **Shinichi Kurita & Wendell T. Blonigan**
Title: **Process Chamber Lid Open Equipment**

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Transmitted herewith is the patent application identified above, including:

- ☒ Specification, claims and abstract, totaling 12 pages.
- ☒ Drawings totaling 4 pages, Formal ☒ Informal.
- ☒ Executed Declaration and Power of Attorney.
- ☒ Assignment of the invention to Applied Materials, Inc.
- ☒ Assignment Recordation Cover Sheet

FEE CALCULATION					
Fee Items	Claims Filed	Included With Basic Fee	Extra Claims	Fee Rate	Total
Total Claims	6	- 20 =	0	X \$18	\$0
Independent Claims	2	- 3 =	0	X \$78	\$0
Basic Filing Fee				\$690	\$690
TOTAL FEES					\$690

- ☒ The Commissioner is hereby authorized to charge \$690 to Deposit Account No. 50-1074.
- ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-1074. A duplicate copy of this transmittal is enclosed.
- ☒ Please address all future correspondence to:
**PATENT COUNSEL
APPLIED MATERIALS, INC.
Legal Affairs Department
P.O.BOX 450A
Santa Clara, CA. 95052**

I hereby certify that this correspondence is being deposited with the United States Postal Service as express mail in an envelope addressed to Box Patent Application, Assistant Commissioner for Patents, Washington, D.C. 20231

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Respectfully submitted,
[Signature]
Robert W. Mulcahy
Registration No. 25,436

PROCESS CHAMBER LID OPEN EQUIPMENT

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to the fields of semiconductor manufacturing. More specifically, the present invention relates to process chamber lid open equipment.

Description of the Related Art

During chemical vapor deposition (CVD) processing, reactive gases released inside a process chamber form layers, such as silicon oxides or nitrides, on the surface of a substrate being processed. During this process, oxide/nitride deposition occurs

elsewhere in the CVD apparatus. The oxide/nitride residue has a deleterious effect on the CVD process if the CVD apparatus is not periodically cleaned. To avoid these deleterious effects, periodic cleaning procedures are undertaken to remove the oxide/nitride residue every N wafers/substrates, where N is an integer.

The cleaning procedures, however, result in periodic down-time for the CVD system, thereby reducing the system throughput. To reduce the total down-time of the CVD system, two types of cleaning techniques are employed: a gas-clean technique and a wet-clean technique. During a gas-clean technique, a cleaning gas, such as oxygen, NF.sub.3, helium and/or nitrogen, is flowed into the process chamber to remove oxide residue present therein. The gas-clean technique is achieved without breaking the vacuum seal of the process chamber, the seal being formed when a lid associated with the process chamber is in a closed position. This technique minimizes the amount of down-time necessary to perform the cleaning procedure. The gas-clean technique is unable to remove a portion of the oxide residue present in the CVD system, necessitating a periodic wet-clean technique. During a wet-clean technique, the vacuum seal of the process chamber is broken by moving the chamber lid to an open position. A user physically wipes down the chamber using chemical cleaners. Thus, the wet-clean technique is substantially more time-consuming than the gas-clean technique, thereby increasing the down-time of the CVD system.

The prior art is deficient in the lack of a CVD system which may reduce the time required for wet-cleaning. Specifically, the prior art is deficient in the lack of integration of lid open equipment at each CVD process chamber, which is capable of moving the process chamber lid up/down (open/close condition) and rotating the lid 180 degrees. The present invention fulfills this long-standing need and desire in the art.

SUMMARY OF THE INVENTION

In one aspect of the present invention, there is provided is a lid assembly for a chemical vapor deposition (CVD) process chamber, comprising a moveable lid, two linear guide rollers, one or more linear lifting actuators, and a rotation actuator. Optionally, the lid assembly may comprise one or more gas springs to support the weight of the lid. The two linear guide rollers are parallel to each other and both are connected to the lid, one on each end of the axis of the lid. The linear lifting actuators move the lid up and down along the linear guide rollers, while the rotation actuator is connected to the axis of the lid and rotates the lid once the lid is lifted to a upper limit. This lid assembly may be used for opening/closing process chamber in chemical vapor deposition (CVD) processes.

In another aspect of the present invention, there is provided is a method of wet-cleaning the process chamber in a chemical vapor deposition procedure. This method comprises the steps of (1) lifting the process chamber lid up by linear lifting actuators; (2) rotating the lid 180 degrees on the axis by a rotation actuator; (3) lowering the lid to below the process chamber, thereby breaking the vacuum seal of the process chamber; and (4) wiping down the chamber using chemical cleaners. During step (1), the lid is moved along linear guide rollers, which are connected to the axis of the lid.

Other and further aspects, features, and advantages of the present invention will be apparent from the following description of the embodiments of the invention given for the purpose of disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the matter in which the above-recited features, advantages and objects of the invention, as well as others which will become clear, are attained and can be understood in detail, more particular descriptions of the invention briefly summarized above may be had by reference to certain embodiments thereof which are illustrated in the appended drawings. These drawings form a part of the specification. It is to be noted, however, that the appended

drawings illustrate embodiments of the invention and therefore are not to be considered limiting in their scope.

Figure 1 is an over view of process chamber lid open mechanism showing lifting linear actuator **101**, linear guide roller **102**, gas spring **103**, spur gear reduction **104**, gear **105** with a cover (at removed condition), rotation actuator **106**, motor controller **107** and a moveable lid **108**.

Figures 2A-2C show process chamber lid open mechanism operation steps, wherein the lid is first lifted up (**Figure 2A**), rotated 180 degrees (**Figure 2B**) and then lowered 600 mm (**Figure 2C**).

Figure 3 is a side view of lid working area demonstrating process chamber lid open mechanism dimension.

DETAILED DESCRIPTION OF THE INVENTION

Provided herein is a process chamber lid open/close equipment, comprising a moveable lid **108**, two lifting linear actuators **101** (one on each end of the axis of the lid), two linear guide rollers **102** (one on each end of the axis of the lid), two gas springs **103**, spur gear reduction **104**, gear **105**, a rotation actuator **106**, and a motor controller **107** (Figure 1). The dimension of the process chamber lid open mechanism is further shown in Figure 3.

A lid open/close mechanism is constructed with linear guide rollers **102** and linear lifting actuators **101**. The lid is supported at the linear guide rollers **102** and operated up or down by lifting linear actuators **101** to a upper (open) or lower (close) limit. Two lifting linear actuators **101** are installed at both ends of the axis of the lid so that the linear actuators do not inhibit to access below process chamber. Process chamber has a controller and related equipment in the middle lower portion. Some indicator and switch are constructed for the control. No equipment is allowed to block/cover the surface of the control panel. Lid weight is supported by two gas springs **103** to reduce the load of rotation actuator **106**.

A lid rotation mechanism is constructed with gear **105** and rotation actuator **106** connected to the movable lid **108**. The lid rotation mechanism is not operational unless the lid reaches to the upper limit.

Such integration of lid open equipment at each chemical vapor deposition (CVD) process chamber is capable of moving the process chamber lid up/down (open/close condition) and rotating the lid 180 degrees.

Compared with conventional lid open/close and rotation mechanisms, the presently disclosed process chamber lid open mechanism is easy for lid maintenance such as wet cleaning shower head and/or process chamber. The lid can be lowered from 1.8 m to 1.2 m at shower head surface from floor level. Additionally, the present lid open equipment makes it easier to disconnect radiofrequency (RF) power, signal cable and cooling water, since the lid can be lifted straight up.

To operate the process chamber lid open equipment disclosed herein, the lid is first lifted up to the upper limit (Figure 2A), then rotated 180 degrees (Figure 2B) and last lowered 600 mm (Figure 2C).

As described above, provided herein is a lid assembly for chemical vapor deposition (CVD) process chamber, comprising a moveable lid, two linear guide rollers, one or more linear lifting actuators, and a rotation actuator. Optionally, the lid assembly may comprise one or more gas springs to support the weight of the lid. The two linear guide rollers are parallel to each other and both are connected to the lid, one on each end of the axis of the lid. The

linear lifting actuators move the lid up and down along the linear guide rollers, while the rotation actuator is connected to the axis of the lid and rotates the lid once the lid is lifted to the upper limit. Specifically, the lid can be lowered up to 600 mm by the linear lifting actuators and rotated up to 180 degrees by the rotation actuator.

The presently disclosed lid assembly may be used for opening/closing the process chamber in chemical vapor deposition (CVD) processes. Specifically, the process chamber is in an open condition when the lid is moved up by the linear lifting actuators to an upper limit, whereas the process chamber is in a close condition when the lid is moved down by the linear lifting actuators to a lower limit.

Also provided herein is a method of wet-cleaning a process chamber in chemical vapor deposition. This method comprises the steps of (1) lifting up the process chamber lid by linear lifting actuators; (2) rotating the lid 180 degrees on the axis by a rotation actuator; (3) lowering the lid to below the process chamber, thereby breaking the vacuum seal of the process chamber; and (4) wiping down the chamber using chemical cleaners. During step (1), the lid is moved along linear guide rollers, which are connected to the axis of the lid.

Any patents or publications mentioned in this specification are indicative of the levels of those skilled in the art to

which the invention pertains. These patents and publications are herein incorporated by reference to the same extent as if each individual publication was specifically and individually indicated to be incorporated by reference.

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One skilled in the art will readily appreciate that the present invention is well adapted to carry out the objects and obtain the ends and advantages mentioned, as well as those inherent therein. It will be apparent to those skilled in the art that various
10 modifications and variations can be made in practicing the present invention without departing from the spirit or scope of the invention. Changes therein and other uses will occur to those skilled in the art which are encompassed within the spirit of the invention as defined by the scope of the claims.

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WHAT IS CLAIMED IS:

1. A lid assembly for a chemical vapor deposition (CVD) process chamber, comprising:

a moveable lid;

a first linear guide roller and a second linear guide roller, wherein said first linear guide roller is parallel to said second linear guide roller, and wherein both linear guide rollers are connected to said lid, one linear guide roller on each end of a lateral side of the lid, wherein said lateral side is the axis on which the lid rotates;

one or more linear lifting actuators, wherein said linear lifting actuators move the lid up and down along said linear guide rollers; and

a rotation actuator, wherein said rotation actuator is connected to said lateral side of the lid and rotates the lid.

2. The lid assembly of claim 1, further comprising:

one or more gas springs, wherein said gas springs support the weight of the lid.

3. The lid assembly of claim 1, wherein said lid can be lowered up to 600 mm by said linear lifting actuators.

4. The lid assembly of claim 1, wherein said lid can be rotated up to 180 degrees by said rotation actuator.

5 5. A method of opening and closing a process chamber in a chemical vapor deposition (CVD) process, comprising the step of:

applying the lid assembly of claim 1 in chemical vapor deposition, wherein the process chamber is in an open condition when the lid is moved up by the linear lifting actuators to a upper limit, and wherein the process chamber is in a closed condition when the lid is moved down by the linear lifting actuators to a lower limit.

15 6. A method of wet-cleaning a process chamber in a chemical vapor deposition procedure, comprising the steps of:

lifting process chamber lid up by linear lifting actuators, wherein said lid is moved along linear guide rollers, and wherein said linear guide rollers are connected to the axis of the lid;

20 rotating said lid 180 degrees on the axis by a rotation actuator;

lowering the lid to below the process chamber, thereby breaking the vacuum seal of the process chamber; and

25 wiping down the chamber using chemical cleaners, whereby the process chamber is cleaned.

ABSTRACT OF THE DISCLOSURE

5 Provided herein is a lid assembly for chemical vapor
deposition (CVD) process chamber, comprising a moveable lid, two
linear guide rollers connected to the lid, one or more linear lifting
actuators, and a rotation actuator connected to the axis of the lid.
This lid assembly may be used for opening/closing process chamber
as well as wet-cleaning process chamber in chemical vapor
10 deposition.

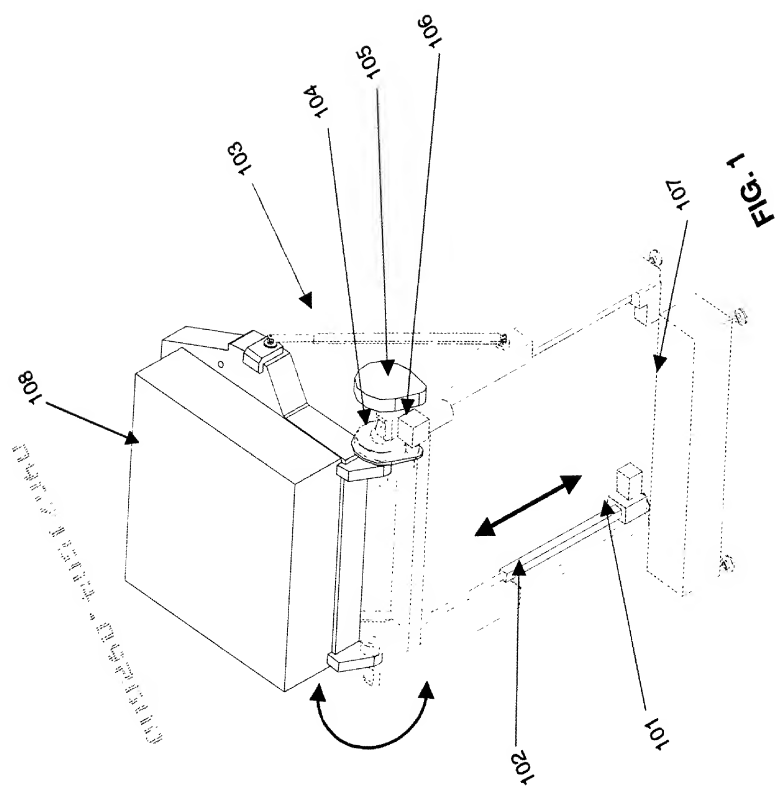


FIG. 2A

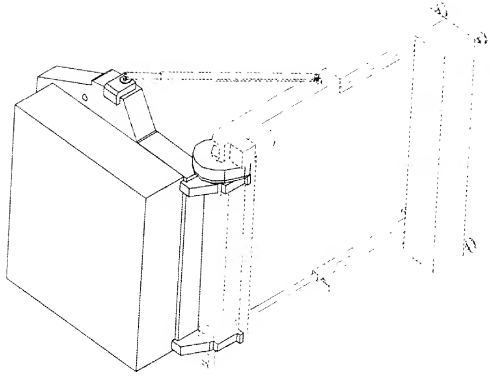


FIG. 2B

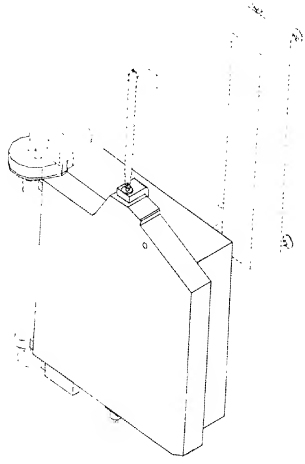


FIG. 2A and FIG. 2B are perspective views of the device shown in FIG. 1, with the circular component removed.

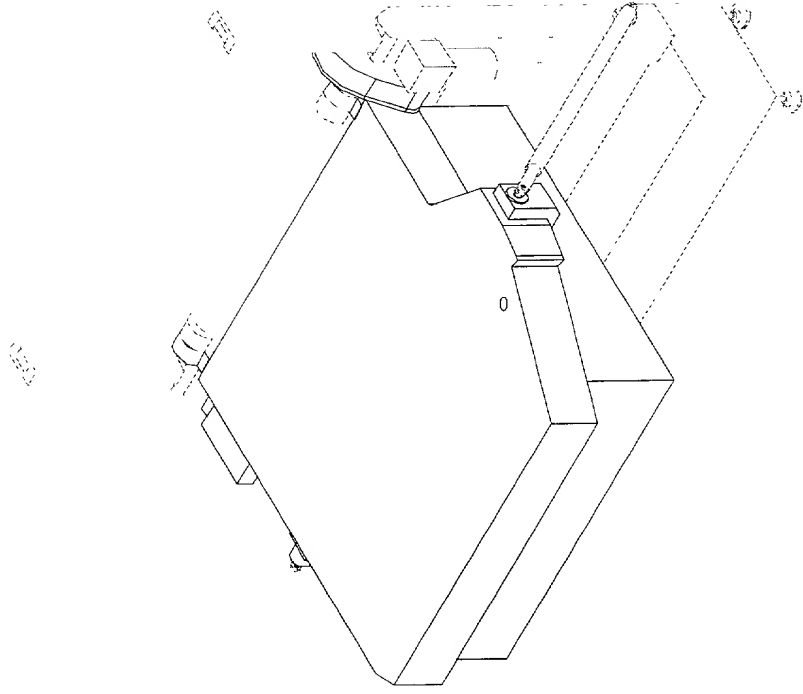


FIG. 2C

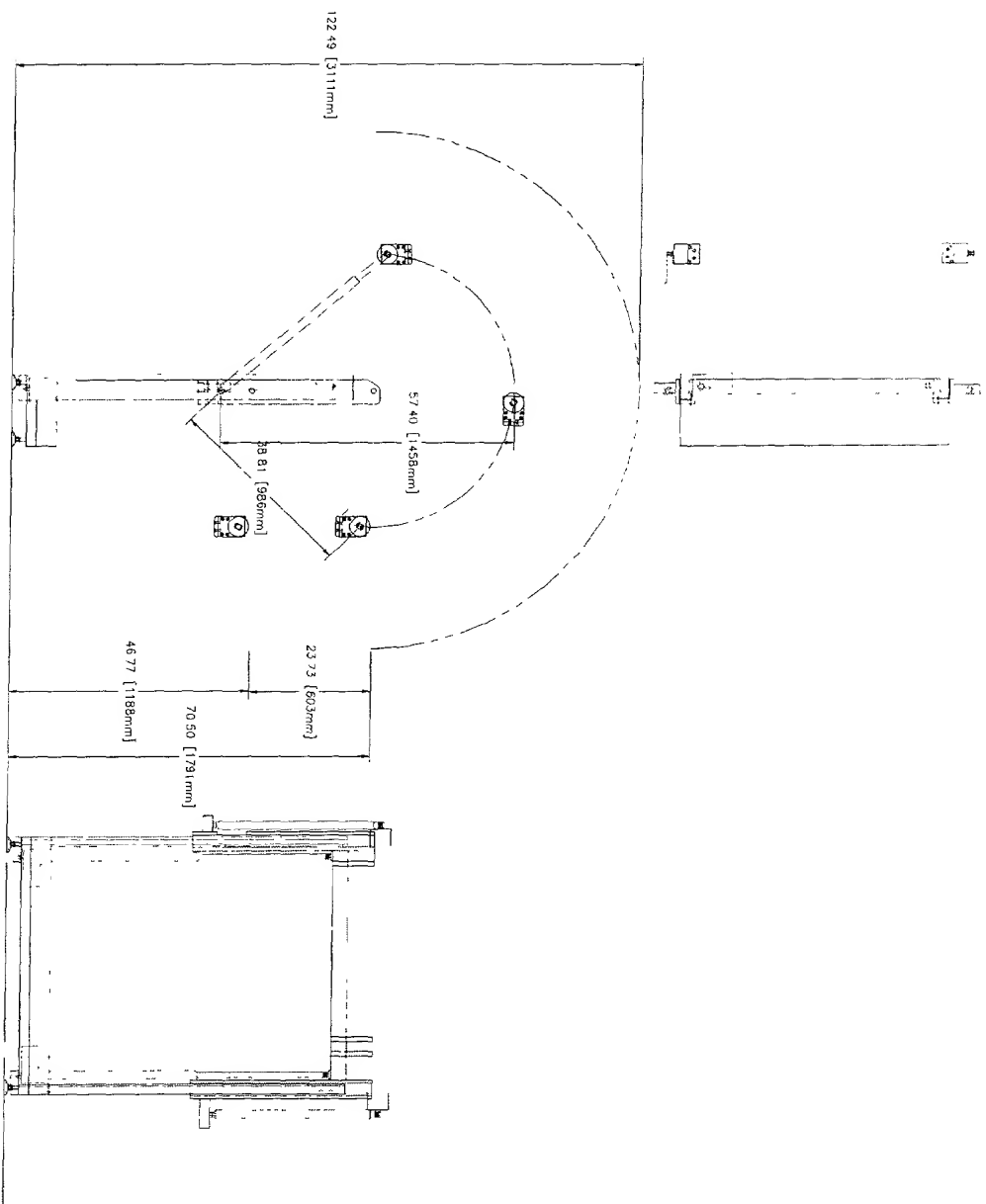


FIG. 3

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COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

This declaration is of the following type:

- ☒ original
☐ divisional
☐ continuation
☐ continuation-in-part

INVENTORSHIP IDENTIFICATION

My residence, post office address and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

Process Chamber Lid Open Equipment

SPECIFICATION IDENTIFICATION

The specification of which:

- ☒ is attached hereto
☐ was filed on {Filing Date}, under Serial No. {Serial No.}, executed on even date herewith; or ☐ Express Mail No.(as Serial No. not yet known) and was amended on _____ (if applicable)
☐ was described and claimed in PCT International Application No. _____ filed on _____ and as amended under PCT Article 19 on _____.

ACKNOWLEDGMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information I know to be material to patentability in accordance with Title 37, Code of Federal Regulations, 1.56, and which is material to the examination of this application; namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and

- ☐ In compliance with this duty there is attached an Information Disclosure Statement in accordance with 37 CFR 1.98.

PRIORITY CLAIM (35 U.S.C. §119)

I hereby claim foreign priority benefits under Title 35, United States Code, §119, of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America or of any United States Provisional Application(s) listed below, and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

- ☒ No such applications have been filed.

☐ Such applications have been filed as follows:

- A. Prior foreign/PCT/provisional application(s) filed within 12 mos. (6 mos. for design) prior to this application, and any priority claims under 35 U.S.C. § 119

<u>Country/PCT</u>	<u>Application No</u>	<u>Date Filed</u>	<u>Priority Claimed</u>	
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No

- B. All foreign application(s), if any, filed more than 12 mos. (6 mos for design) prior to this U.S. application

Country:
Application No:
Filing date:

PRIORITY CLAIM (35 U.S.C. §120)

I hereby claim the benefit under Title 35, United States Code, § 120, of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, '112, I acknowledge the duty to disclose information that is material to the examination of this application (namely, information where there is substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application.

- ☒ No such applications have been filed
☐ Such applications have been filed, as follows:

<u>Serial No.</u>	<u>Filing Date</u>	<u>Status</u>	
		<u>Patented Pending</u>	<u>Abandoned</u>

POWER OF ATTORNEY

I hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

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DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and, further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Sec. 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

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Inventor's signature: _____

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(Declaration ends with this page)